REFLECTANCE AND TRANSMISSION MEASUREMENTS IN SUPPORT OF THE EMISSIVITY MEASUREMENTS IN THE PLANETARY EMISSIVITY LABORATORY (PEL). A. Maturilli, J. Helbert, and M. D'Amore, Institute for Planetary Research, DLR, Rutherfordstrasse 2, 12489, Berlin, Germany (alessandro.maturilli@dlr.de)

Introduction: The Institute for Planetary Research has an expertise in spectroscopy of minerals, rocks, meteorites, and organic matter, build up in more than two decades. The available equipment allows spectroscopy from the visible to TIR range using biconical reflection, transmission and emission spectroscopy. The institute has an outstanding heritage in designing and building infrared remote-sensing instruments for planetary missions.

The PEL has been operating in various configurations for the last 10 years. The laboratory experimental facilities consist of the main emissivity spectrometer laboratory, a supporting spectrometer laboratory for reflectance, low-moderate temperature emissivity, and transmission measurements, sample preparation facilities and an extensive collection of rocks and minerals.

Laboratory set-up: The heart of the spectroscopic facilities is the Planetary Emissivity Laboratory (PEL), that allows to measure the emissivity of planetary analogue materials in the 1-50 μm spectral range, with grain size separates 0-25, 25-63, 63-125, and 125-250 μm.

Figure 1: View of the main facility in the PEL

The laboratory spectrometer is a new Bruker VERTEX 80V FTIR spectrometer, having a very high spectral resolution (better then 0.2 cm-1), and a resolving power of better than 300,000:1, and can be operated under vacuum conditions to remove atmospheric features from the spectra.

The spectrometer is currently coupled to a newly completed planetary simulation chamber (see Figure 2). This chamber can be evacuated so that the full optical path from the sample to the detector is free of any influence by atmospheric gases. The chamber has an automatic sample transport system which allows to maintain the vacuum while changing the samples.

Figure 2: The planetary simulation chamber (top cover removed)

The induction heating system that is permanently installed in the new chamber allows to heat the samples to temperatures of up to 700K permitting measurements under realistic conditions for the surface of Mercury. Further details on this instrumentation for high temperature messurements under vacuum can be found in [5].

Supporting instrumentation: As it is shown in Figure 1, in the PEL two parallel instruments are able of measuring emissivity: the one already described, and an older Bruker IFS88 with attached an emissivity chamber, which has been developed at DLR. It is a double-walled water-cooled box with three apertures: a 15 cm squared door used to insert the cup in the box, a 5 cm rounded opening through which the beam is directed to the spectrometer and a 5 cm opening facing the attached blackbody unit. A heater is placed in the chamber and is used to heat the cup with samples from the bottom, up to 160° C. The thermal radiation emitted normal to the surface by the sample or the blackbody is collected by an Au-coated parabolic off-axis mirror and reflected to the entrance port of the spectrometer. The chamber (visible in Figure 3, without the cover) is purged with dry air to remove particulates, water vapour and CO2. Further details can be found in [1, 2].

Complementary measurements: By means of the Bruker A513 accessory, we obtain specular reflectance of minerals, with variable incoming and outcoming angles (between 13° and 85°). We can measure room

temperature samples, under purged air or under vacuum conditions, covering the 1 to 50 µm spectral range.

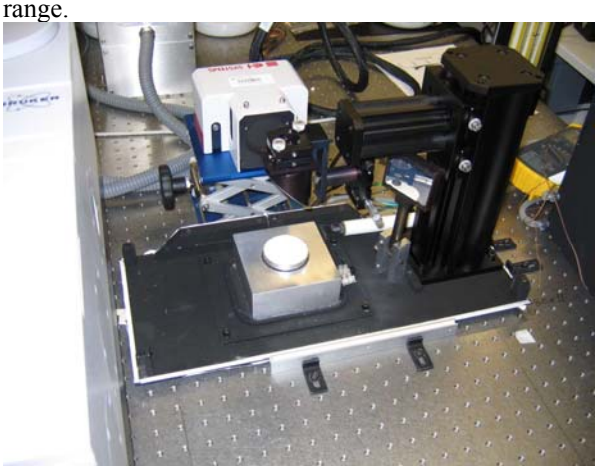

Figure 3: Old emissivity chamber

Such measurements can be used even to complete the emissivity measurements we can perform, especially in the case of a very limited amount of the available material. Figure 4 shows the measured reflectance for a sample of quartz in the smaller size separate we usually consider for our materials.

The Bruker A480 parallel beam accessory allows us to accurately measure transmission of thin slabs of material, optical filters, optical window materials, etc, in the complete 1 to 50 µm spectral range. Such a device, allows us to avoid refraction (causing focus and lateral beam shifts), typical in this kind of measurements. In Figure 5 the transmission spectral of a filter is shown.

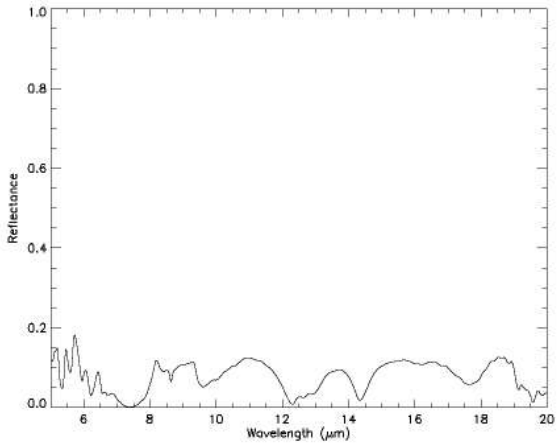

Figure 4: Quartz 0-25 µm reflectance spectrum

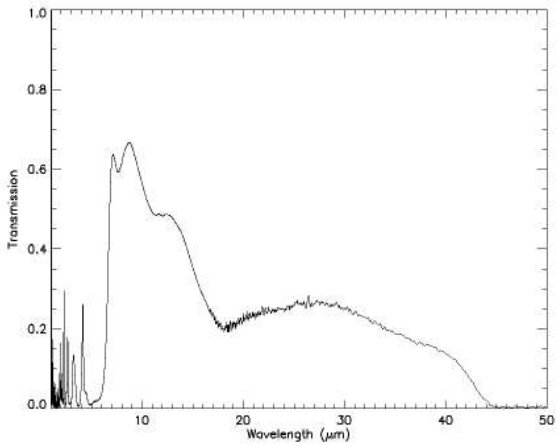

Figure 5: Transmission spectrum of a filter

Summary: The PEL provide the planetary community already today with emissivity measurements highly complementary to exisiting spectral databases. With the 2009 upgrade the PEL allows unique measurements with a strong focus on airless bodies and extreme conditions as the ones BepiColombo and MESSENGER will encounter at Mercury, over the extremely wide spectral range from 1-50 µm for fine grained samples. Two accessories permit complementary measurements of reflectance and transmission in the same large spectral range. A second instrument is used to measure emissivity of moderate temperature bodies, under purged air conditions.

References: [1] A. Maturilli, J. Helbert et al. (2006), *PSS 54*. [2] A. Maturilli, J. Helbert, et al. (2007), *PSS 56*. [3] Helbert, J. et al. (2007), *ASR 40*. [4] J. Benkhoff, J. Helbert, et al. (2006) ASR, 38, 4. [5] J. Helbert, A. Maturilli (2009), *this meeting*.